and tip flow conditions (such as velocity diagrams and blade draw?), which were not. For example, it is not clear whether the “S” variant, probably due to more favorable rotor inlet flow angles. These results suggest that conical contouring, with appropriate rotor design, could be superior to the S wall type in terms of overall stage performance.

Acknowledgments

The authors are indebted to J. P. Huot for his assistance in the evaluation of these results, and to B. J. Day and D. L. Logan for their work in securing the experimental data.

References


DISCUSSION

R. J. Roelke

The authors are to be commended on the extent of the investigation undertaken. However, the very large number of design option investigations made it difficult at times to sort out which were beneficial to the turbine performance and which were not. For example, it is not clear whether the “S” contoured stator or the conical stator was better, or was it a draw? I also would have liked more information defining the hub and tip flow conditions (such as velocity diagrams and blade surface velocities) since it was at those locations that most of the losses occurred. Having that information in the paper would have aided in the discussion of the test results. Lastly, but perhaps most importantly, is the clear need for analysis and design tools that better model the flow physics of small turbomachines where viscous effects play such a dominant role.

Authors' Closure

The authors thank Mr. Roelke for his comments, and are keenly aware that space constraints precluded inclusion of all
aspects of the investigation. In particular, we agree that the optimum design is not a clear-cut choice. The example cited by Mr. Roelke is a good example of some of the complexities involved.

Initial work with the nozzle operating as an isolated annular cascade suggested that the “S” contour had lower losses than the “C” variant. Subsequent experiments in a stage environment showed that under those conditions the “C” nozzle had the lower overall loss, reflecting the rotor interaction effect discussed in [12]. The flow turning achieved with the “C” nozzle, however, did not match the design value, and this led to a reduction in rotor performance. In terms of overall stage efficiency, therefore, the stage with the “C” nozzle proved inferior to that with the “S” nozzle. The results suggest that, with appropriate redesign to accommodate the flow angles involved, the “C” contour could eventually prove superior in terms of overall stage efficiency. Further work is planned, and will be reported in due course.